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TECHNICAL MEMORANDUM

Date: June 30, 2015
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Subject: I-70 East Ramp Metering Assessment

The purpose of this technical memorandum is to provide an inventory of the existing ramp metering along I-70 East, and a recommendation for locations to provide ramp metering along the reconstructed I-70 corridor.

The existing ramps along the I-70 corridor from Washington Street to Peoria Street were reviewed. Ramp information is described in Table 1, including ramp length, the number of ramp lanes, ramp traffic volumes, the presence of existing ramp metering, and ramp metering equipment. Ramp traffic volume data was obtained from CDOT.

The proposed ramps along the corridor then were evaluated. Similar to the existing ramp inventory, the proposed ramp lengths, number of lanes, and anticipated future ramp volumes are documented in Table 1. The westbound York Street interchange and the eastbound Steele Street/Vasquez Boulevard on-ramp are being eliminated as part of the proposed design; therefore, no proposed ramp information is provided at these locations. The existing Stapleton Drive ramps are being redesigned as the westbound Holly Street and Dahlia Street and eastbound Holly Street and Monaco Street ramps under the proposed design. Anticipated future ramp volumes were obtained from the DynusT model.

Ramp metering design guidance was reviewed to aid in the determination of the proposed ramps. Taken from CDOT's February 18, 2004, Memorandum for the use of variable speed limit implementation, "CDOT is currently using a Ramp Metering Feasibility Study that was conducted for Region 6. It recommends using a three-tiered approach for determining viable ramp meter locations. Two of the tiers are derived from warrants established by Arizona Department of Transportation (ADOT) and California Department of Transportation (Caltrans). The third tier is based on the Region's field observations and experience with the current ramp metering system. The study performed by the ADOT provides volume thresholds for installing ramp meters. The warrant criterion states if a ramp plus mainline volume upstream of the gore exceeds the following volume thresholds, a meter may be warranted."

ADOT

- 2 mainline lanes: 2,650 vehicles per hour (vph)
- 3 mainline lanes: 4,250 vph
- 4 mainline lanes: 5,850 vph

In addition to the ADOT warrants, Caltrans provides guidelines for installing single-lane metered entrance ramps versus two-lane metered entrance ramps. The suggested volume thresholds are listed below.

CALTRANS

- Single-lane metered entrance ramp for volumes up to 900 vph

- Two-lane metered entrance ramps for volumes above 900 vph

Per the ADOT Ramp Metering Guide, November 2013, there are several indicators for whether ramp metering is warranted. If acceptable acceleration distance and queuing storage cannot be achieved, then ramp metering is not warranted. Based on the Caltrans Ramp Meter Design Manual, the standard acceleration distance is a minimum of 500 feet from the ramp meter stop bar to the theoretical gore. The ramp's queue storage distance is based on the ramp volumes; therefore, this distance varies for each ramp. After these geometry questions have been evaluated, then volume questions are evaluated, as described below:

- **Warrant 1—Freeway Right-Lane and Entrance Ramp Flow Rate**
  During a typical 15-minute period, the combining flow rate of the entrance ramp and the right-most freeway lane is greater than 2,050 vehicles per hour; during the same period, the entrance ramp flow rate is greater than 400 vehicles per hour.

- **Warrant 2—Freeway Speed**
  During a typical 15-minute period, the speed of the freeway general-purpose lanes (not including HOV, auxiliary, and entrance-ramp lanes) is less than 50 mph due to recurring congestion adjacent to or within two miles downstream of the entrance ramp.

It is suggested that if the answer to either or both of these questions is no, then ramp metering is not warranted. If the answer to Warrant 1 is yes and Warrant 2 is no, then ramp metering is not warranted. If the answer to both Warrant 1 and 2 is yes, then ramp metering is warranted. However, CDOT Region 1 has indicated that all on ramps in the Denver metro will be ramp metered system wide and measures will be put into place to time and design the ramp meters accordingly.

Based on geometric and traffic volume evaluations, the recommendations for ramp metering along this section of the I-70 corridor are provided in Table 1.

Table 1—Existing and Proposed I-70 Ramp Information

Ramp	Existing Ramp Length	Proposed Ramp Length	Existing No. of Lanes	Proposed No. of Metered Lanes	2012 PM Existing Ramp Volumes (vph)	2021 PM Proposed Ramp Volumes (vph)	2021 PM Proposed Mainline Volume Upstream of On-ramp Gore (vph)	2021 PM Combined Proposed and Mainline Volume (vph)	Description of Existing Equipment	**Recommendation**
WB Washington St	Physical Gore—475' Theoretical Gore—860'	No Change	2	No Change	1,548	1,637	2,145	3,782	No ramp meter	Ramp metering
EB Washington St	Physical Gore—885' Theoretical Gore—1,195'	No Change	2	No Change	293	1,056	6,434	7,490	No ramp meter	Ramp metering
WB Brighton Blvd	Physical Gore—550' Theoretical Gore—985'	Physical Gore—304' Theoretical Gore—1,038'	1	2	544	931	6,134	7,065	No ramp meter	Ramp metering
EB Brighton Blvd	Physical Gore—772' Theoretical Gore—1,093'	Physical Gore—430' Theoretical Gore—778'	1	2	1,015	1,319	5,153	6,472	No ramp meter	Ramp metering
WB York St	Physical Gore—578' Theoretical Gore—695'	N/A	1	N/A	629	N/A	N/A	N/A	No ramp meter	N/A
WB Vasquez Blvd	Physical Gore—768' Theoretical Gore—876'	Physical Gore—913' Theoretical Gore—1,939'	1	1	654	822	5,928	6,750	No ramp meter	Ramp metering
EB Vasquez Blvd	Physical Gore—842' Theoretical Gore—959'	N/A	1	N/A	766	N/A	N/A	N/A	No ramp meter	N/A
WB Colorado Blvd	Physical Gore—482' Theoretical Gore—556'	Physical Gore—1,324' Theoretical Gore—2,108'	1	2	761	635	5,290	5,925	No ramp meter	Ramp metering
EB Colorado Blvd	Physical Gore—486' Theoretical Gore—566'	Physical Gore—640' Theoretical Gore—1,129'	1	2	222	1,177	5,179	6,356	No ramp meter	Ramp metering
WB Stapleton Dr/ Dahlia St	Physical Gore—333' Theoretical Gore—488'	N/A	1	N/A	678	N/A	N/A	N/A	No ramp meter	N/A
EB Stapleton Dr/ Monaco St	Stop Bar—267' Physical Gore—452' Theoretical Gore—573'	N/A	1	N/A	612	N/A	N/A	N/A	Ground Mounted—2 Poles Removed in Project	N/A
WB Holly	N/A	Physical Gore—548' Theoretical Gore—1,159'	N/A	2	N/A	795	5,935	6,730	N/A	Ramp metering
EB Holly	N/A	Physical Gore—932' Theoretical Gore—1,730'	N/A	2	N/A	528	5,558	6,086	N/A	Ramp metering
WB Quebec St	Physical Gore—724' Theoretical Gore—804'	Physical Gore—752' Theoretical Gore—944'	1	2	747	723	5,396	6,119	No ramp meter	Ramp metering
EB Quebec St	Stop Bar—504' Physical Gore—696' Theoretical Gore—840'	Physical Gore—651' Theoretical Gore—812'	2	2	1,035	1,158	5,088	6,246	Existing Ground Mounted—2 Poles	Ramp metering
WB Central Park Blvd	Stop Bar—1,343' Physical Gore—2,067' Theoretical Gore—2,341'	Physical Gore—1,986' Theoretical Gore—2,350'	2	2	493	895	5,557	6,452	Existing Ground Mounted—2 Poles	Ramp metering
EB Central Park Blvd	Stop Bar—843' Physical Gore—1,463' Theoretical Gore—1,688'	Physical Gore—1,415' Theoretical Gore—1,761'	2	2	768	776	8,412	9,188	Existing Ground Mounted—2 Poles	Ramp metering
WB Havana St	Stop Bar—882' Physical Gore—963' Theoretical Gore—1,165'	Physical Gore—901' Theoretical Gore—1,447'	2	2	631	1,033	7,630	8,663	Existing Ground Mounted—2 Poles	Ramp metering
EB Havana St	Stop Bar—748' Physical Gore—1,039' Theoretical Gore—1,124'	Physical Gore—985' Theoretical Gore—1,126'	1	1	377	561	8,483	9,044	Existing Ground Mounted—2 Poles	Ramp metering
WB Peoria St	Stop Bar—990' Physical Gore—1,012' Theoretical Gore—1,231'	Physical Gore—1,000' Theoretical Gore—1,376'	2	2	1,158	1,257	6,927	8,184	Existing Ground Mounted—2 Poles	Ramp metering
EB Peoria St	Stop Bar—800' Physical Gore—987' Theoretical Gore—1,210'	Physical Gore—962' Theoretical Gore—1,220'	2	2	1,108	1,088	9,184	10,272	Existing Ground Mounted—2 Poles	Ramp metering
I-270 EB on Ramp to I-70	Physical Gore—2,250' Theoretical Gore—3,400'	Physical Gore—2,070' Theoretical Gore—2,370'	2	2	2,137	2,658	5,791	8,449	N/A	Ramp Metering

N/A—Not Applicable to Proposed Design